DEVELOPMENT OF SIAU TAGULANDANG BIARO TOURISM INDUSTRY POST COVID 19

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Abstract

The Covid 19 pandemic has significantly impacted the tourism industry, requiring areas such as the Siau Tagulandang Biaro Islands Regency to reevaluate their strategy. Identification of the key strategic initiatives is paramount to a successful tourism plan. Because these initiatives are often defined using vague and uncertain perceptions or gray areas, the Fuzzy-AHP methodology was identified and used to determine the value of each criterion and sub-criteria and establish strategic recommendations. The analysis results show that facilities are the highest criterion (34.4% AHP; 24.7% Fuzzy-AHP). The global weight calculation shows hygiene and health are priority elements (8.6% AHP; 8.2% Fuzzy-AHP). The sensitivity analysis shows that the results are robust, consistent, and stable. These results indicate no significant difference between the AHP and Fuzzy-AHP methods. The tourism development strategy for Siau Tagulandang Biaro regency must prioritize improving the cleanliness and health of tourist destinations.

Keywords: Siau Tagulandang Biaro, Fuzzy-AHP, tourism, decision, pandemic

1. Introduction

The Covid 19 pandemic has significantly impacted the decline in tourism and the community's economy. This is especially true for areas highly dependent on tourism, such as the island regency (Bulchand-gidumal, 2022). The archipelago, remotely located quite far from the center of government and has limited industry and trade opportunities, depends on tourism to boost its economy. For this reason, it is necessary to define new strategies and efforts to increase tourism. The main concern is safety and health for both tourists and the local community.

The Siau Tagulandang Biaro Islands Regency is an archipelago consisting of 47 islands, and only ten are inhabited. This area offers a natural habitat, beautiful sea views, and the active Karangetang volcano.

Given the considerable potential for tourism growth, the need for a focused strategic plan for tourism development in the regency is crucial. This study explores the priority strategy for developing volcanic island tourism for the Sitaro Islands Regency.

2. Literature Review

Several previous studies have revealed that small islands have tourism potential and are ideal places to rest and relax because they are far from the city's hustle. The atmosphere is calm, and guests and tourists will find it peaceful, providing a sense of timelessness. It makes them especially attractive (Stylidis & Terzidou, 2017).

Small islands usually have beautiful beaches and abundant marine riches. The relatively small number of residents and the location is far from the bustling center of a big city, making this area relatively safe, clean, and pandemic-free. (Kurniawan, Adrianto, Bengen, & Prasetyo, 2016). Politically the islands are stable. Small islands are often associated with three 'S': ' sea, sun, and sand,' where tourism is a significant component of economic development (Soomauroo, Blechinger, & Creutzig, 2020). Tourism accounts for a large percentage of the 'total gross domestic product (Bulchand-gidumal, 2022).

The location can be reached by fast boat in 4 hours or by plane in 30 minutes from Manado, the capital city of North Sulawesi, Indonesia.

2.2. AHP and Fuzzy-AHP

The Analytic Hierarchy Process method is commonly used in multicriteria decision-making, including determining strategic priorities, which will be used to focus the planning agenda. Saaty introduced this method in the 1970s.

Advantages of AHP include; the ability to quantitatively measure subjective topics and to reconstruct complex problems into a hierarchical structure to make them easy to solve (Ohoitimur, Krejci, Raco, Raton, & Taroreh, 2019). Questionnaires were designed in pairwise comparison, which made it easier for the respondents to determine their preferences. This method is a good combination of quantitative and qualitative approaches (Javanbarg, Scawthorn, Kiyono, & Shahbodaghkhan, 2012). This method has proven helpful for decision-makers to formulate the management policies of their businesses. Many researchers use it for scientific studies.

AHP has limitations. It uses discrete numbers and does not adequately address uncertainties. Anticipating this drawback, the researchers also applied Fuzzy-AHP, which can calculate and address vagueness. One of the study's objectives was to compare the finding provided by both methods.

The researchers started by explaining the steps of the AHP, beginning with determining the research goal, then defining and setting up the criteria and sub-criteria, including alternatives. It structures them in the form of a hierarchy.

Fuzzy-AHP

It has been determined that when the preferences are uncertain and cannot easily be determined using exact numerical values, AHP is insufficient (Javanbarg et al., 2012). Human understanding of complex issues was imprecise (Wang & Chen, n.d.). The real world is highly ambiguous and challenging to be understood quantitatively (Javanbarg et al., 2012).

To minimize these problems, Zadeh introduced the fuzzy method in 1965 to rationalize uncertainties concerning vagueness and thus make them applicable to human thought. Fuzzy methods continue to develop. Today, there are many fuzzy methods, one of which is Fuzzy-AHP.

In Fuzzy-AHP, the crisp value is replaced with a triangular fuzzy number (TFN) to mitigate the lack of knowledge on the topic that would result in hesitation (Kulisic, Dimitriou, & Mola-yudego, 2021). Human understanding of complex issues is imprecise because the real world is highly ambiguous and challenging to understand quantitatively (Jozef Richard Raco et al., 2022). TFN is a multi-directional approach with three real numbers as its membership element (*l, m, u*), where *l, m,* and *u* are the lesser, middle, and higher boundaries of the TFN (Paul & Ghosh, 2022).

2.3. Sensitivity Analysis

Sensitivity analysis is a fundamental concept in the Multi-Criteria Decision-Making (MCDM) method to measure stability, consistency, and robustness in the selection of the optimal solution in the event of a change in policy or additional information that requires the decision-maker to change its policy and result in a change in the priority order.

Sensitivity analysis is a dynamic element of a hierarchy. This means that the assessment made the first time is maintained for a certain period, and if there is a change in policy or sufficient action to be carried out, sensitivity analysis helps to see the effects that could occur. Sensitivity analysis helps decision-makers to understand the strength of the decision to be taken (J.R Raco et al., 2021).

3. Methodology

The researcher first determined the research objectives and then identified important factors and sub-factors related to island tourism development through a literature review and previous studies. The factors and sub-factors are arranged in a hierarchical form to facilitate completion. After that, the researcher compiled a questionnaire in the form of pairwise comparisons which the expert respondents filled in by following the Saaty comparison scale. They are officials and tourism actors in Siau Tagulandang Biaro Regency.

The data collected is then averaged using the geometric mean formula.

$$GM = \sqrt[n]{(x_1)(x_2)\dots(x_n)} \quad \text{.....(1)}$$

The results are aggregated using the formula below:

$$A = [a_{ij}],\ a_{ij} = w_i/w_j,\ a_{ji} = 1/a_{ij}, a_{ii} = 1 \quad \text{.....(2)}$$

After that, the data is normalized using the following formula:

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad \text{.....(3)}$$

Then calculate the priority value using the formula below:

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \quad \text{.....(4)}$$

To guarantee that the results obtained are consistent, the index consistency calculation is performed using the formula below:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad \text{.....(5)}$$

Then calculate the consistency ratio:

$$CR = \frac{CI}{RI} \text{.....(6)}$$

The value of the Ratio Index using the table below:

Table 1. Ratio Index

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.000	0.000	0.580	0.900	1.120	1.240	1.320	1.410	1.450	1.490	1.510	1.480	1.560	1.570	1.590

The consistent AHP results are then converted into the Fuzzy-AHP form using the scale in table 2 below.
Table 2. AHP and F – AHP scale

Linguistic variables	AHP Scale	Fuzzy AHP Scale	
		TFNs	Reciprocal TFNs
Equal Importance	1	(1, 1, 1) diagonal	(1, 1, 1)
Intermediate	2	(1, 2, 3)	(1/3, 1/2, 1)
Moderately more important	3	(2, 3, 4)	(1/4, 1/3, 1/2)
Intermediate	4	(3, 4, 5)	(1/5, 1/4, 1/3)
Strongly more important	5	(4, 5, 6)	(1/6, 1/5, 1/4)
Intermediate	6	(5, 6, 7)	(1/7, 1/6, 1/5)
Very strongly more important	7	(6, 7, 8)	(1/8, 1/7, 1/6)
Intermediate	8	(7, 8, 9)	(1/9, 1/8, 1/7)
Extremely more important	9	(8, 9,9)	(1/9, 1/9,1/8)

The sixth step is to determine the weight of respondents' perceptions using Fuzzy AHP according to Buckley as follows:

Step 1. Compile a pairwise comparison matrix of criteria and sub-criteria as follows:

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \ldots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \cdots & 1 \end{bmatrix} \quad (7)$$

With,

$$\tilde{a}_{ij} = \begin{cases} \tilde{1}, \tilde{3}, \tilde{5}, \tilde{7}, \tilde{9}, criterion\ i\ is\ relative\ importance\ to\ criterion\ j \\ 1, \ i = j \\ \tilde{1}^{-1}, \tilde{3}^{-1}, \tilde{5}^{-1}, \tilde{7}^{-1}, \tilde{9}^{-1}, criterion\ i\ is\ relative\ less\ importance\ to\ criterion\ j \end{cases}$$

Step 2. Calculating the geometric mean of the fuzzy comparison value of criterion *i* to each criterion using the following formula

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \cdots \otimes \tilde{a}_{in})^{1/n} \quad (8)$$

Where, $\tilde{a}_{in}$ is fuzzy comparison value of criterion *i* to criterion *n*.

Step 3. Determine the fuzzy weight of each criterion indicated by the triangular fuzzy number

$$\widetilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \cdots \oplus \tilde{r}_n)^{-1} \quad (9)$$

Where, $\widetilde{w}_i$ is the fuzzy weight of the *i*th criterion and can be indicated using a triangular fuzzy number, $\widetilde{w}_i = (Lw_i, Mw_i, Uw_i)$. $Lw_i, Mw_i \; and \; Uw_i$ is the lower, middle, and upper value of the fuzzy weight of the *i*th criterion.

Step 4. The process of defuzzification used the Center of Area method to get the weight of Best Nonfuzzy Performance (BNP) by applying the formula 10,

$$BNP_{w_i} = [(Uw_i - \ Lw_i) + (Mw_i - Lw_i)]/3 + Lw_i \quad (10)$$

The next step is the sensitivity analysis calculation to assess the robustness of the priority factors in the event of a change in the criteria. If there is a change in the criteria and the priority factors do not change, it can be said that these priority factors can be used in policymaking. However, if there is a change in the criteria and the priority factors change, then policymakers must be careful in using these priority factors, and it is essential always to pay attention if there is a change.

4. Results

4.1. Result comparison between AHP and Fuzzy-AHP

The weight of respondents' perceptions from the results of data analysis using the AHP and Fuzzy-AHP methods for the criteria is listed in table 3 and figure 1 below.

Table 3. The weight of respondents' perception for the criteria

Criteria	Weight	
	AHP	F-AHP
A. Human resources	0.133	0.134
B. Infrastructure	0.169	0.170
C. Facilities	0.347	0.344
D. Community behavior	0.181	0.181
E. Place/destination of tourism	0.172	0.170

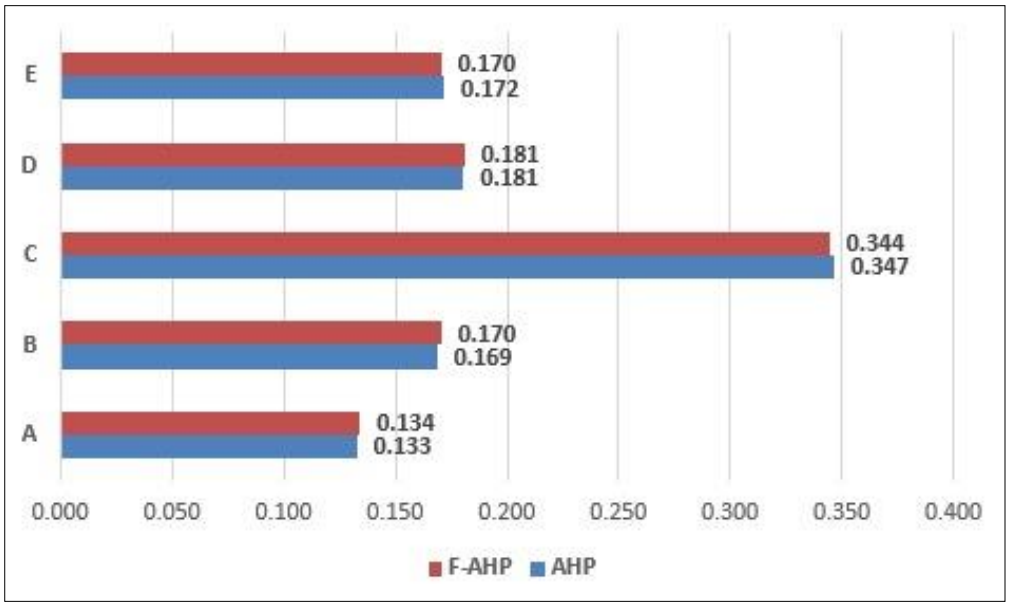

Figure 1. The weight of respondents' perceptions for the criteria

The weight of respondents' perceptions from the results of data analysis using the AHP and F-AHP methods for the human resources sub-criteria is listed in table 4 and figure 2 below

Table 4 the weight of respondents' perception on sub criteria human resources

Criteria	Weight	
	AHP	F-AHP
A1. Education of local community	0.330	0.333
A2. Training/certificate of local tourist guide	0.544	0.539
A3. Hiring an external tourist guide	0.126	0.129

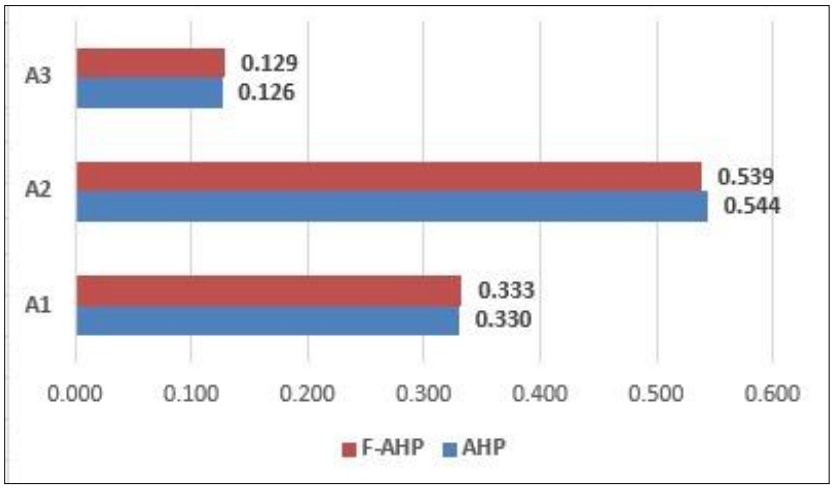

Figure 2. Weight of respondents' perception on sub-criteria of human resources

The weight of respondents' perceptions from the results of data analysis using the AHP and F-AHP methods for infrastructure sub criteria is listed in table 5 and figure 3 below.

Table 5. Weight of respondents' perception on sub criteria of infrastructure

Criteria	Weight	
	AHP	F-AHP
B1. Roads/bridges	0.242	0.241
B2. Piers/harbor	0.263	0.259
B3. Airport	0.246	0.253
B4. Evacuation path	0.249	0.247

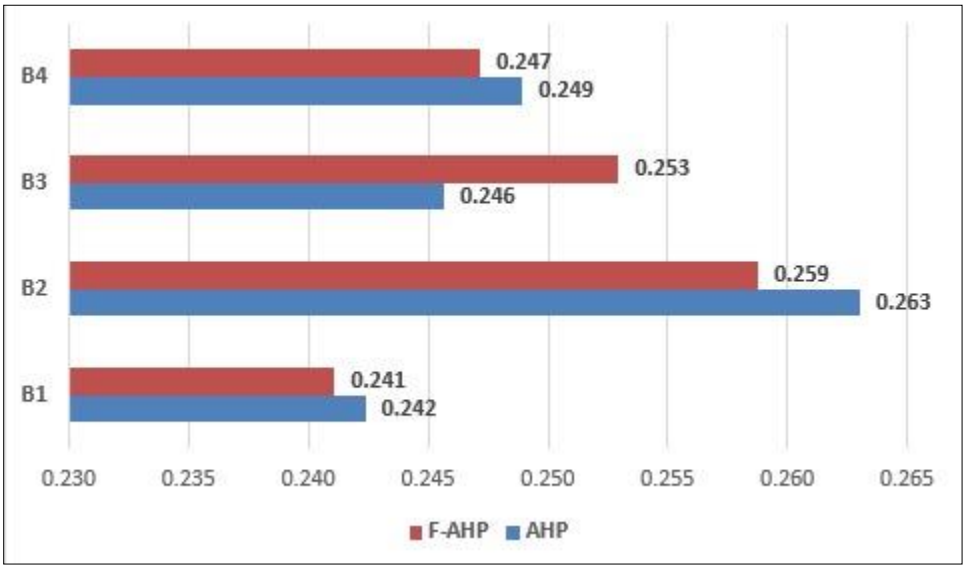

Figure 3. Weight of respondent's perception of sub-criteria infrastructure

Respondents' perception weight resulting from data analysis using the AHP and F-AHP methods for the facilities sub-criteria are listed in table 6 and figure 4 below.

Table 6. Weight of respondents' perception of sub-criteria facilities

Criteria	Weight	
	AHP	F-AHP
C1. Clean water	0.151	0.149
C2. Electricity	0.157	0.156
C3. Waste treatment	0.155	0.156
C4. Accommodation/hotel/lodging	0.150	0.152
C5. Communication network/internet/WIFI	0.178	0.177
C6. Hospital/medical doctor specialist	0.209	0.210

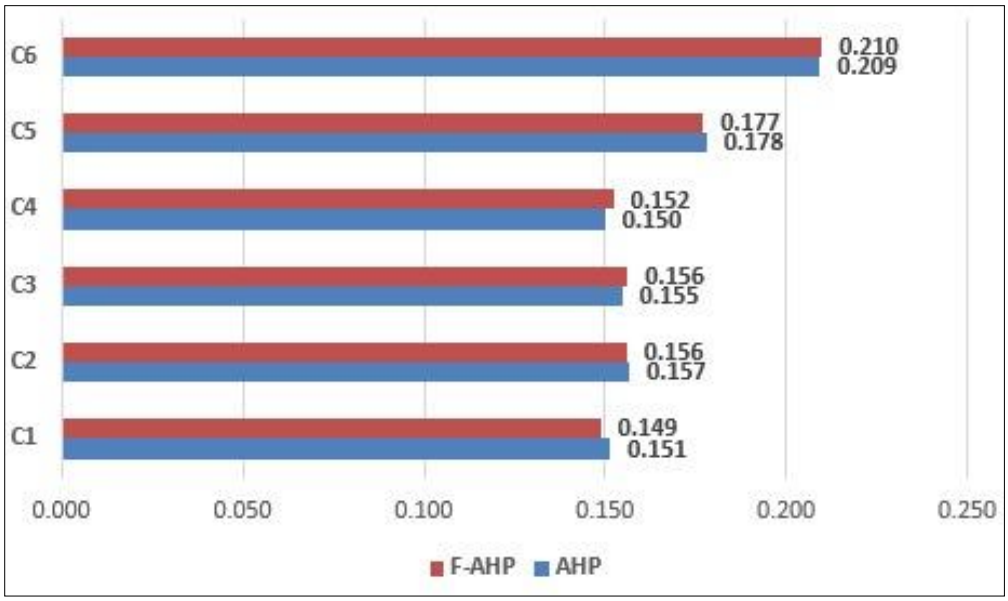

Figure 4. Weight of respondent's perception of sub-criteria of facilities

The weight of respondents' perceptions from the results of data analysis using the AHP and F-AHP methods for sub-criteria for community behavior is listed in table 7 and figure 5 below.

Table 7. Weight of respondents' perception of sub-criteria of community behavior

Criteria	Weight	
	AHP	F-AHP
D1. The welcoming attitude of tourism	0.306	0.304
D2. Security surrounding	0.242	0.243
D3. Cleanliness and healthy surroundings/ community	0.453	0.453

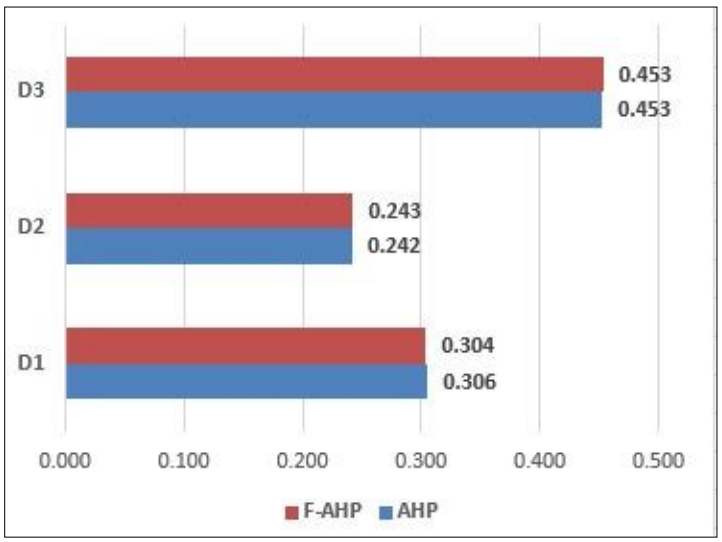

Figure 5. Weight of respondents' perception of sub-criteria of community behavior

The weight of respondents' perceptions from the results of data analysis using the AHP and F-AHP methods for the sub-criteria for tourist destinations is listed in table 8 and figure 6 below

Table 8. Weight of respondents' perceptions for sub-criteria for tourist destinations

Criteria	Weight	
	AHP	F-AHP
E1. Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	0.500	0.499
E2. Promotion and cultural events	0.252	0.252
E3. Protect the cultural sites and historical heritage of the area	0.249	0.249

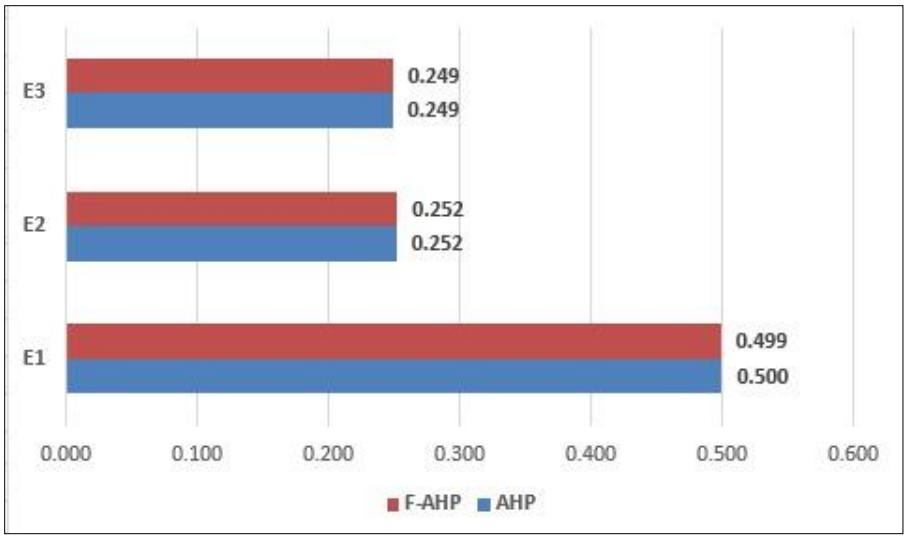

Figure 6. Weight of respondents' perception of sub-criteria of the place of tourist destination

The results of the Global Calculation showed in table 9.

Table 9. Global calculation result

Criteria / Sub Criteria		Local Weight		Global Weight	
		AHP	F-AHP	AHP	F-AHP
Human resources	A			0.133	0.134
Infrastructure	B			0.169	0.170
Facilities	C			0.347	0.344
Community behavior	D			0.181	0.181
Place/tourist destination	E			0.172	0.170
	SUM			**1.000**	**1.000**
Education of local community	A1	0.330	0.333	0.044	0.045
Training/certificate of the local guide	A2	0.544	0.539	**0.072**	**0.072**
Hiring external guide	A3	0.126	0.129	0.017	0.017
	SUM	**1.000**	**1.000**	**0.133**	**0.134**

Roads/bridges	B1	0.242	0.241	0.041	0.041
Harbor/piers	B2	0.263	0.259	0.044	0.044
Airport	B3	0.246	0.253	0.041	0.043
Evacuation path	B4	0.249	0.247	0.042	0.042
	SUM	**1.000**	**1.000**	**0.169**	**0.170**
Clean water	C1	0.151	0.149	0.052	0.051
Electricity	C2	0.157	0.156	0.054	0.054
Waste treatment	C3	0.155	0.156	0.054	0.054
Accommodation/hotel/lodging	C4	0.150	0.152	0.052	0.052
Communication network/internet/wife	C5	0.178	0.177	0.062	0.061
Hospital/medical doctor specialist	C6	0.209	0.210	**0.073**	**0.072**
	SUM	**1.000**	**1.000**	**0.347**	**0.344**
Local welcoming tourist	D1	0.306	0.304	0.055	0.055
Security of surrounding	D2	0.242	0.243	0.044	0.044
Cleanliness and healthy surrounding	D3	0.453	0.453	**0.082**	**0.082**
	SUM	**1.000**	**1.000**	**0.181**	**0.181**
Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	E1	0.500	0.499	**0.086**	**0.085**
Promotion and cultural events	E2	0.252	0.252	0.043	0.043
Protect the cultural sites and historical heritage of the area	E3	0.249	0.249	0.043	0.042
	SUM	**1.000**	**1.000**	**0.172**	**0.170**

Sensitivity Analysis

Sensitivity analysis is carried out by comparing the original results with the designed scenario. In the original result, the weight of the criteria, starting from the largest, is facilities (C) of 34.7%, community behavior (D) 18.1%, tourist destinations (E) 17.2%, infrastructure (B) 16.9%, human resources (A) 13.3%. While the global weight of the biggest sub-criteria is maintaining ecosystems and cleanliness of beaches/lakes/hot springs (E1) of 8.6%. The results of the sensitivity analysis are listed in table 10 below.

Scenario 1, the weight of all criteria is made equal. The result is the global weight of the biggest sub-criteria Local tour guide training / certification (A2) of 10.9%.

Table 10. Results of the sensitivity analysis

Criteria / Sub Criteria		**Weight**		
		Original	**Scenario 1**	**Scenario 2**
Human resources	A	0.133	0.200	0.133
Infrastructure	B	0.169	0.200	0.169
Facilities	C	0.347	0.200	0.247
Community behavior	D	0.181	0.200	0.281
Place/tourist destination	E	0.172	0.200	0.172
Education of local community	A1	0.044	0.066	0.044
Training/certificate of local tour guide	A2	0.072	**0.109**	0.072
Hiring an external tour guide	A3	0.017	0.025	0.017
Roads/bridges	B1	0.041	0.048	0.041
Harbor/piers	B2	0.044	0.053	0.044

Airport	B3	0.041	0.049	0.042
Evacuation path	B4	0.042	0.050	0.042
Clean water	C1	0.052	0.030	0.037
Electricity	C2	0.054	0.031	0.039
Waste treatment	C3	0.054	0.031	0.038
Accommodation/hotel/lodging	C4	0.052	0.030	0.037
Communication network/internet/wife	C5	0.062	0.036	0.044
Hospital/medical doctor specialist	C6	**0.073**	0.042	0.052
Welcoming behavior of locals toward tourists	D1	0.055	0.061	**0.086**
Security of surrounding	D2	0.044	0.048	0.068
Personal and environmental hygiene/health	D3	**0.082**	**0.091**	**0.127**
Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	E1	**0.086**	**0.100**	**0.086**
Promotion and cultural events	E2	0.043	0.050	0.043
Protect the cultural sites and historical heritage of the area	E3	0.043	0.050	0.043

Scenario 2, the weight of the most significant criterion in the original result is reduced by 10% while the weight of the second largest criterion is increased by 10%. In this case, the weight of the Facility criteria (C) is reduced by 10%, and the weight of the Community Behavior criteria (D) is increased by 10%. The results obtained for the most significant global weight sub-criteria were personal and environmental hygiene/health at 12.7%.

5. Discussion

Researchers used AHP and Fuzzy-AHP methods to determine tourism development priorities in Siau Tagulandang Biaro Islands Regency. The analysis results show that the criteria for facilities are the highest (AHP – 34.4%; Fuzzy-AHP – 34.7%), followed by community behavior, tourist destinations, infrastructure, and human resources. The results of calculating the criteria using the AHP and Fuzzy-AHP methods are not much different, and the arrangement is the same.

The results of the global weight analysis show that sub-criterion E1, namely maintaining the cleanliness of beaches and tourist facilities, is the highest (AHP - 8.6; Fuzzy-AHP - 8.5%) and following D3, namely health factors both environmental and public health (AHP - 8.2%; Fuzzy -AHP – 8.2%). These global weight calculation results are the same for both AHP and Fuzzy-AHP. This shows that tourism development in the Kepualaun Siau Tagulandang Biaro Regency must pay attention to environmental hygiene and health.

Nature tourism, such as beaches and seascapes, is very appealing today. Cleanliness and health are the principal demands of tourists who wish to enjoy nature (Campos et al., 2022). This is in line with previous research by Suarez-Rojas et al. (2023) that cleanliness is an essential factor for marine tourism, so efforts to clean the sea from trash are significant (Suarez-Rojas, Leon, & Lam-Gonzalez, 2023). Kari Hyytiainen (2022) adds that the cleanliness of the island's beaches is a critical element in attracting tourists (Hyytiainem et al., 2022). According to Cristina Roman (2022), organizers of island tourism must guarantee an integrated system between ecosystems and environmental cleanliness, including beaches, so that sustainability can be achieved (Cristina Román, 2022) (Román, Borja, Uyarra, & Pouso, 2022). Surveys conducted in the Netherlands confirm that when choosing beach tourism, tourists will prioritize clean tourist areas (Bettencourt, Freitas, Costa, & Caeiro, 2023). Chanittha Chansuk (2022) emphasized that cleanliness and health are critical factors for tourism development (Chansuk et al., 2022).

The results of the sensitivity analysis show that the decision is not robust. This means that if there is a change in the weight of the criteria, it will impact changes in the weight of the sub-criteria. The actual

result was that the highest weighted criterion was facilities (34.7%), with the highest sub-criteria weighting maintaining ecosystems and cleanliness of beaches/lakes/hot springs (E1) of 8.6%. In scenario one, all sub-criteria weights were made equal, each of which was 20%; the most significant sub-criteria weight was obtained for the Local tour guide training/certification (A2) sub-criteria of 10.9%. In scenario 2, the weight of the first and second biggest criteria is exchanged by 10%, and the most considerable sub-criteria weight is personal and environmental hygiene/health by 12.7%.

6. Conclusion

This study aims to determine the Siau Tagulandang Biaro Islands tourism development strategy using a combination of AHP and Fuzzy-AHP methods. The study results show that the facilities, cleanliness, and health of tourist destination areas are the highest and must be prioritized in the regional tourism development policy. The sensitivity analysis results show that the results obtained are not robust. It means that a slight change in the weight of the criteria will bring considerable changes in the sub-criteria.

There is no difference in the calculation results between the AHP and Fuzzy-AHP methods. Both methods are very appropriate for multi-complex decision-making in determining priority strategies.

The results of this study contribute to the management of tourism development in Siau Tagulandang Biaro regency Islands in determining policies and planning.

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